WHAT IS CLAIMED IS:

1. A method for configuring a downlink signal in an orthogonal frequency division multiplexing access - frequency division duplexing (OFDMA-FDD) mobile communication system, comprising:

(a) configuring a downlink frame with a plurality of symbols; and

(b) inserting pilot subcarriers into each symbol to be distributively arranged therein with respect to a time axis and a frequency axis, part of pilot subcarriers being reference for a mobile station to perform time synchronization, frequency synchronization, and cell search.

2. A method for configuring a downlink signal in an orthogonal frequency division multiplexing access - time division duplexing (OFDMA-TDD) mobile communication system, comprising:

(a) configuring a downlink frame with a plurality of symbols, the downlink frame and a seamless uplink frame forming a frame of the mobile communication system; and

(b) inserting pilot subcarriers into each symbol to be distributively arranged therein with respect to a time axis and a frequency axis, part of pilot subcarriers being reference for a mobile station to perform time synchronization, frequency synchronization, and cell search.

3. The method of claim 1 or 2, wherein the pilot subcarriers

are inserted at regular intervals with respect to time domain, and are inserted at irregular intervals with respect to frequency domain.

4. The method of claim 3, wherein the pilot subcarriers are inserted according to position sets of pilot subcarriers proper to cells.

5. The method of claim 4, wherein proper position sets of pilot subcarriers are allocated in the case of adjacent cells, and position sets of pilot subcarriers are allocated so that the minimum subcarriers may be superimposed in the case of non-adjacent cells when the number of cells is greater than an available number of the proper position sets of pilot subcarriers.

6. The method of claim 5, wherein proper pilot subcarriers corresponding to a predetermined number generated by dividing the number of subcarriers by the number of cells are allocated for each cell, and

as to insufficient pilot subcarriers, the cells are divided into cell groups including cells, and part of the proper pilot subcarriers are allocated to the cells which have the same position in different groups to configure a position set of pilot subcarriers for each cell.

7. The method of claim 6, wherein, as to a prime number which is less than a value generated by dividing the number Nu of subcarriers by the number Np of subcarriers included in the cell group, a predetermined number of cells (less than the prime number) are combined to be a plurality of cell groups, a default sequence h_{imodg}

specified by a cell group number of i is allocated to each cell group, and the position set of pilot subcarriers is allocated to each cell of cell groups according to the subsequent equations:

$$K = \{f_{K,0}, f_{K,1}, \cdots, f_{K,gNp-1}\}$$
$$h_i(k) = v(k) + (ik) mod g$$
$$K_{ig+j} = \{f_{K,r} | \, r = kg + (h_{imodg}(k) + j) mod g\}$$

where K is a set of subcarriers for transmitting pilot subcarriers, v(k) is a specified pseudo random sequence having values of from 0 to (g-1), and K_{ig+j} is a set of pilot subcarriers having the cell group number of i and the cell number of j.

8. The method of claim 6, wherein, as to a prime number which is less than a value generated by dividing the number of subcarriers by the number of subcarriers included in the cell group, a predetermined number of cells (less than the prime number) are combined to be a plurality of cell groups, a default sequence h_{imodg} specified by a cell group number of i is allocated to each cell group, and the position set of pilot subcarriers is allocated to each cell of cell groups according to the subsequent equations, and the pilot subcarriers are not punctured and transmitted at a position other than the position of subcarriers used for transmission to the mobile station.

$$K = \{f_{K,0}, f_{K,1}, \cdots, f_{K,gNp-1}\}$$
$$h_i(k) = v(k) + (ik) mod g$$
$$K_{ig+j} = \{f_{K,r} | \, r = kg + (h_{imodg}(k) + j) mod g\}$$

where K is a set of subcarriers for transmitting pilot subcarriers, v(k) is a specified pseudo random sequence having values of from 0 to (g-1), and K_{ig+j} is a set of pilot subcarriers having the cell group number of i and the cell number of j.

9. The method of claim 2, wherein the position set of pilot subcarriers applied to the downlink frame is established to be different from the position set of pilot subcarriers applied to the uplink frame in order to identify the downlink frame and the uplink frame.

10. A device for configuring a downlink signal in an orthogonal frequency division multiplexing access - frequency division duplexing (OFDMA-FDD) mobile communication system, comprising:

a pilot generator for generating a pilot symbol pattern according to external cell number information and a position set pattern of pilot subcarriers, the pilot symbol pattern being inserted into symbols when the downlink frame includes the symbols, and the position set pattern of pilot subcarriers being proper to each cell and including a plurality of pilot subcarriers which are distributively arranged with respect to the time axis and frequency axis for each symbol and are references for a mobile station to perform time synchronization, frequency synchronization, and cell search; and

a symbol mapper for mapping external input traffic data information with respect to time and frequency based on the pilot symbol pattern and the position set pattern of pilot subcarriers

generated by the pilot generator, and outputting mapped signals to a transmitter of the mobile communication system.

11. A method for initially synchronizing a downlink signal and searching a cell in an orthogonal frequency division multiplexing access - frequency division duplexing (OFDMA-FDD) mobile communication system wherein a frame of the downlink signal includes a plurality of symbols in which pilot subcarriers are distributively arranged with respect to the time axis and frequency axis, the method comprising:

(a) using a position at which autocorrelation of a cyclic prefix of the downlink signal and a valid symbol of the downlink signal is maximized, and estimating initial symbol synchronization and initial frequency synchronization;

(b) using pilot subcarriers included in the symbol having the estimated initial symbol synchronization and initial frequency synchronization, and estimating cell search and integer-times frequency synchronization;

(c) using the estimated cell search result and estimating fine symbol synchronization;

(d) using the estimated cell search result and estimating fine frequency synchronization; and

(e) estimating frame synchronization of the downlink.

12. A method for initially synchronizing a downlink signal and

searching a cell in an orthogonal frequency division multiplexing access - time division duplexing (OFDMA-TDD) mobile communication system wherein a frame of the downlink signal includes a plurality of symbols in which pilot subcarriers are distributively arranged with respect to the time axis and frequency axis, and a downlink frame and a seamless uplink frame form a frame in the mobile communication system, the method comprising:

(a) using a position at which autocorrelation of a cyclic prefix of the downlink signal and a valid symbol of the downlink signal is maximized, and estimating initial symbol synchronization and initial frequency synchronization;

(b) using pilot subcarriers included in the symbol having the estimated initial symbol synchronization and initial frequency synchronization, and estimating cell search, integer-times frequency synchronization, and a downlink estimation;

(c) using the estimated cell search result and tracking the downlink;

(d) using the estimated cell search result and estimating fine symbol synchronization;

(e) using the estimated cell search result and estimating fine frequency synchronization; and

(f) estimating frame synchronization of the downlink.

13. The method of claim 11 or 12, wherein the method

comprises, after estimating frame synchronization of the downlink:

(i) tracking the frequency and time of the downlink;

(ii) using the position set of pilot subcarriers inserted into the downlink frame, and tracking the cell;

(iii) using the position set of pilot subcarriers, and tracking symbol synchronization; and

(iv) using the pilot subcarriers, and tracking fine frequency synchronization, and

the steps of (i), (ii), (iii), and (iv) are repeated to track the frequency and time of the downlink frame.

14. The method of claim 12, wherein the synchronization process for the downlink signal is stopped and the steps of (a) to (f) are repeated after a predetermined symbol interval, when the link is found to be an uplink in (b).

15. A device for synchronizing a downlink signal in an orthogonal frequency division multiplexing access - frequency division duplexing (OFDMA-FDD) mobile communication system wherein a frame of the downlink signal includes a plurality of symbols in which pilot subcarriers are distributively arranged with respect to the time axis and frequency axis, the device comprising:

an initial synchronization estimator for estimating initial symbol synchronization and initial frequency synchronization of the downlink signal, using the estimated results and information stored in

a cell information storage unit, and performing cell search, integer-times frequency synchronization estimation, fine symbol synchronization estimation, fine frequency synchronization estimation, and frame synchronization estimation;

a cell information storage unit for storing information on the cells included in the mobile communication system when the initial synchronization is performed by the initial synchronization estimator; and

a tracker for using a position set of pilot subcarriers properly allocated to each cell, and performing cell tracking, fine symbol synchronization tracking, and fine frequency synchronization tracking.

16. A device for initially synchronizing a downlink signal in an orthogonal frequency division multiplexing access - time division duplexing (OFDMA-TDD) mobile communication system wherein a frame of the downlink signal includes a plurality of symbols in which pilot subcarriers are distributively arranged with respect to the time axis and frequency axis, and a downlink frame and a seamless uplink frame form a frame of the mobile communication system, the device comprising:

an initial synchronization estimator for estimating initial symbol synchronization and initial frequency synchronization of the downlink signal, using the estimated results and information stored in a cell information storage unit, and performing cell search, integer-

times frequency synchronization estimation, downlink estimation, downlink tracking, fine symbol synchronization estimation, fine frequency synchronization estimation, and frame synchronization estimation;

a cell information storage unit for storing information on the cells included in the mobile communication system when the initial synchronization is performed by the initial synchronization estimator; and

a tracker for using a position set of pilot subcarriers properly allocated to each cell, and performing cell tracking, fine symbol synchronization tracking, and fine frequency synchronization tracking.

17. The device of claim 15, wherein the initial synchronization estimator comprises:

an initial symbol synchronization and initial frequency synchronization estimator for using a position at which autocorrelation of a cyclic prefix of the downlink signal and a valid symbol of the downlink signal is maximized, and estimating initial symbol synchronization and initial frequency synchronization;

a cell search and integer-times frequency synchronization estimator for using pilot subcarriers included in the symbol estimated by the initial symbol synchronization and initial frequency synchronization estimator, and estimating cell search and integer-times frequency synchronization;

a fine symbol synchronization estimator for using a cell search result estimated by the cell search and integer-times frequency synchronization estimator and the pilot subcarrier, and estimating fine symbol synchronization;

a fine frequency synchronization estimator for using a cell search result estimated by the cell search and integer-times frequency synchronization estimator and the pilot subcarrier, and estimating fine frequency synchronization; and

a frame synchronization estimator for using a cell search result estimated by the cell search and integer-times frequency synchronization estimator and the pilot subcarrier, and estimating frame synchronization of the downlink.

18. The device of claim 16, wherein the initial synchronization estimator comprises:

an initial symbol synchronization and initial frequency synchronization estimator for using a position at which autocorrelation of a cyclic prefix of the downlink signal and a valid symbol of the downlink signal is maximized, and estimating initial symbol synchronization and initial frequency synchronization;

a cell search, integer-times frequency synchronization, and downlink estimator for using pilot subcarriers included in the symbol estimated by the initial symbol synchronization and initial frequency synchronization estimator, and estimating cell search, integer-times

frequency synchronization, and a downlink;

a downlink tracker for using the pilot subcarrier included in the symbol estimated by the initial symbol synchronization and initial frequency synchronization estimator, and tracking a downlink;

a fine symbol synchronization estimator for using a cell search result estimated by the cell search, integer-times frequency synchronization, and downlink estimator, a tracking result by the downlink tracker, and the pilot subcarrier, and estimating fine symbol synchronization;

a fine frequency synchronization estimator for using a cell search result estimated by the cell search, integer-times frequency synchronization, and downlink estimator, a tracking result by the downlink tracker, and the pilot subcarrier, and estimating fine frequency synchronization; and

a frame synchronization estimator for using a cell search result estimated by the cell search, integer-times frequency synchronization, and downlink estimator and the pilot subcarrier, and estimating frame synchronization of the downlink.

19. The device of claim 17 or 18, wherein the initial symbol synchronization and initial frequency synchronization estimator comprises:

a delay unit for delaying the downlink signal;

a conjugate complex generator for finding correlation of the

delayed downlink signal and the downlink signal;

a comparator for finding a maximum value of a correlation value from a symbol interval length of the downlink through an output signal of the correlator, and estimating initial symbol synchronization; and

a frequency offset estimator for finding a phase value of autocorrelation from the initial symbol synchronization estimate estimated by the comparator.

20. The device of claim 17, wherein the cell search and integer-times frequency synchronization estimator comprises:

a delay unit for delaying a frequency domain signal generated by performing a Fourier transform on the downlink by a symbol;

an autocorrelator for finding autocorrelation of the downlink signal and a frequency domain signal output by the delay unit within an available integer-times frequency offset range according to a position set of pilot subcarriers for each cell received through a cell information storage unit; and

a comparator for finding a maximum value of the autocorrelation output by the autocorrelator to perform cell search, and finding a maximum value of the autocorrelation according to an integer-times frequency offset available for the position set of pilot subcarriers of the estimated cell to estimate integer-times frequency synchronization.

21. The device of claim 18, wherein the cell search, integer-times frequency synchronization, and downlink estimator comprises:

a delay unit for delaying a frequency domain signal generated by performing a Fourier transform on the downlink by a symbol;

an autocorrelator for finding autocorrelation of the downlink signal and a frequency domain signal output by the delay unit within an available integer-times frequency offset range according to a position set of pilot subcarriers for each cell received through a cell information storage unit; and

a comparator for finding a maximum value of the autocorrelation output by the autocorrelator to perform cell search, and finding a maximum value of the autocorrelation according to an integer-times frequency offset available for the position set of pilot subcarriers of the estimated cell to estimate integer-times frequency synchronization, and comparing an autocorrelation value when the integer-times frequency synchronization is estimated with a predetermined threshold value to perform downlink estimation.

22. The device of claim 18, wherein the downlink tracker comprises:

a delay unit for delaying a frequency domain signal generated by performing a Fourier transform on the downlink by a symbol;

an autocorrelator for finding autocorrelation of the downlink signal and a frequency domain signal output by the delay unit; and

a comparator for comparing an autocorrelation value output by the autocorrelator with a predetermined threshold value to perform downlink tracking.

23. The device of claim 17 or 18, wherein the fine symbol synchronization estimator comprises:

a correlator for performing cross correlation on the frequency domain signal generated by performing Fourier transform on the downlink, a pilot symbol pattern of the estimated cell provided by the cell information storage unit, and a position set of pilot subcarriers;

an inverse Fourier transform unit for performing inverse Fourier transform on the value cross-correlated by the correlator; and

a comparator for finding a value at which the output by the inverse Fourier transform unit is maximized, and estimating fine symbol synchronization.

24. The device of claim 17 or 18, wherein the fine frequency synchronization estimator comprises:

a Fourier transform unit for performing Fourier transform on the downlink signal and outputting a frequency domain signal;

a delay unit for delaying the frequency domain signal by one symbol;

a correlator for performing cross correlation on the delayed signal output by the delay unit and the frequency domain signal output by the Fourier transform unit, as to the position set of pilot subcarriers

of the estimated cell provided by the cell information storage unit; and

a phase estimator for using a phase value of the value cross-correlated by the correlator, and estimating fine frequency synchronization.

25. The device of claim 15 or 16, wherein the tracker comprises:

a cell tracker for using a position set of pilot subcarriers properly allocated to the cell and performing cell tracking;

a fine symbol synchronization tracker for performing inverse Fourier transform on cross correlation of the received pilot subcarrier and a predefined pilot subcarrier, and estimating the position of a maximum value; and

a fine frequency synchronization tracker for using a phase difference between pilot subcarriers of the frequency domain signal generated by performing Fourier transform on the downlink signal, and performing fine frequency tracking.